Anemia and Blood Improvement

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Nutrition rehabilitation of HIV-infected and HIV-negative undernourished children utilizing spirulina.

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The objective of this study was to assess the impact of an alimentary integrator composed of spirulina (Spirulina platensis; SP), produced at the Centre Médical St Camille of Ouagadougou, Burkina Faso, on the nutritional status of undernourished HIV-infected and HIV-negative children. We compared two groups of children: 84 were HIV-infected and 86 were HIV-negative. The duration of the study was 8 weeks. Anthropometric and haematological parameters allowed us to appreciate both the nutritional and biological effect of SP supplement to traditional meals. Rehabilitation with SP shows on average a weight gain of 15 and 25 g/day in HIV-infected and HIV-negative children, respectively. The level of anaemia decreased during the study in all children, but recuperation was less efficient among HIV-infected children. In fact 81.8% of HIV-negative undernourished children recuperated as opposed to 63.6% of HIV-infected children (Z: 1.70 (95% CI -0.366, -0.002, p = 0.088)). Our results confirm that SP is a good food supplement for undernourished children. In particular, rehabilitation with SP also seems to correct anaemia and weight loss in HIV-infected children, and even more quickly in HIV-negative undernourished children.

Publication Types:

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Iron availability from iron-fortified spirulina by an in vitro digestion/Caco-2 cell culture model.

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Iron deficiency, one of the most important nutritional problems in the world, can be caused not only by foods deficient in iron but also by poor availability of dietary iron. Iron food fortification in combination with highly available iron from supplements could effectively reduce this deficiency. The aim of this study was to examine the iron availability from iron-fortified spirulina. We have used an in vitro digestion/Caco-2 cell culture system to measure iron spirulina availability and made a comparison with those of beef, yeast, wheat floor, and iron sulfate plus ascorbic acid as a reference. Iron availability was assessed by ferritin formation in Caco-2 cells exposed to digests containing the same amount of iron. Our results demonstrate a 27% higher ferritin formation from beef and spirulina digests than from digests of yeast and wheat flour. When iron availability was expressed per microgram of iron used in each digest, a 6.5-fold increase appeared using spirulina digest in comparison with meat. In view of this observed high iron availability from spirulina, we conclude that spirulina could represent an adequate source of iron.

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C-phycocyanin, a very potent and novel platelet aggregation inhibitor from Spirulina platensis.

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The aim of this study was to systematically examine the inhibitory mechanisms of C-phycocyanin (C-PC), one of the major phycobiliproteins of Spirulina platensis (a blue-green alga), in platelet activation. In this study, C-PC concentration-dependently (0.5-10 nM) inhibited platelet aggregation stimulated by agonists. C-PC (4 and 8 nM) inhibited intracellular Ca2+ mobilization and thromboxane A2 formation but not phosphoinositide breakdown stimulated by collagen (1 microg/mL) in human platelets. In addition, C-PC (4 and 8 nM) markedly increased levels of cyclic GMP and cyclic GMP-induced vasodilator-stimulated phosphoprotein (VASP) Ser(157) phosphorylation. Rapid phosphorylation of a platelet protein of Mw 47,000 (P47), a marker of protein kinase C activation, was triggered by phorbol-12,13-dibutyrate (150 nM). This phosphorylation was markedly inhibited by C-PC (4 and 8 nM). In addition, C-PC (4 and 8 nM) markedly reduced the electron spin resonance (ESR) signal intensity of hydroxyl radicals in collagen (1 microg/mL)-activated platelets. The present study reports on a novel and very potent (in nanomolar concentrations) antiplatelet agent, C-PC, which is involved in the following inhibitory pathways: (1) C-phycocyanin increases cyclic GMP/VASP Ser157 phosphorylation and subsequently inhibits protein kinase C activity, resulting in inhibition of both P47 phosphorylation and intracellular Ca2+ mobilization, and (2) C-PC may inhibit free radicals (such as hydroxyl radicals) released from activated platelets, which ultimately inhibits platelet aggregation. These results strongly indicate that C-PC appears to represent a novel and potential antiplatelet agent for treatment of arterial thromboembolism.

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Mechanisms involved in the antiplatelet effect of C-phycocyanin.

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C-phycocyanin (cpc), a biliprotein isolated from Spirulina platensis, has been reported to exert many therapeutic and nutritional values. In the present study, we examined whether cpc has an antiplatelet activity in vitro and further investigated the possible anti-aggregatory mechanisms involved. Our results showed that preincubation of cpc (1-50 microg/ml) with rabbit washed platelets dose-dependently inhibited the platelet aggregation induced by collagen (10 microg/ml) or arachidonic acid (100 microm), with an IC50 of about 10 microg/ml. Furthermore, the thromboxane B2 formation caused by collagen or arachidonic acid was significantly inhibited by cpc due to suppression of cyclooxygenase and thromboxane synthase activity. Similarly, the rise of platelet intracellular calcium level stimulated by arachidonic acid and collagen-induced platelet membrane surface glycoprotein IIb/IIIa expression were also attenuated by cpc. In addition, cpc itself significantly increased the platelet membrane fluidity and the cyclic AMP level through inhibiting cyclic AMP phosphodiesterase activity. These findings strongly demonstrate that cpc is an inhibitor of platelet aggregation, which may be associated with mechanisms including inhibition of thromboxane A2 formation, intracellular calcium mobilization and platelet surface glycoprotein IIb/IIIa expression accompanied by increasing cyclic AMP formation and platelet membrane fluidity.

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Supplementary effect of spirulina on hematological status of rats during pregnancy and lactation.

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The effect of Spirulina on iron status was assessed based on hemoglobin, packed cell volume, serum iron, total iron binding capacity and ferritin levels of rats during pregnancy and lactation. Rats were fed 5 different kinds of diets (casein, Spirulina, wheat gluten, Spirulina + wheat gluten, Spirulina without additional vitamins and minerals) each providing 22 percent protein. Diets containing Spirulina alone or in combination with wheat gluten resulted in significantly higher iron storage and hemoglobin contents than casein and wheat gluten diets during the first half of pregnancy and lactation. Wheat gluten diet result in the smallest increase in hemoglobin levels and iron stores compared to other diets. The values of serum iron and iron binding capacity remained unchanged with different diets. Spirulina appears to be effective in improving the iron status of rats during pregnancy and lactation.

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Heparin cofactor II-dependent antithrombin activity of calcium spirulan.

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Calcium spirulan (Ca-SP), a novel sulfated polysaccharide isolated from the blue-green alga Spirulina platensis, enhanced the antithrombin activity of heparin cofactor II (HC II) more than 10000-fold. The apparent second-order rate constant of thrombin inhibition by HC II was calculated to be 4.2 x 10(4) M-1 min-1 in the absence of Ca-SP, and it increased in the presence of 50 micrograms/ml Ca-SP to 4.5 x 10(8) M-1 min-1. Ca-SP effectively induced the formation of a thrombin-HC II complex in plasma. In the presence of Ca-SP, both the recombinant HC II variants Lys173-->Leu and Arg 189-->His, which are defective in interactions with heparin and dermatan sulfate, respectively, inhibited thrombin in a manner similar to native rHC II. This result indicates that the binding site of HC II for Ca-SP is different from the heparin- or dermatan sulfate-binding site. When we removed the calcium from the Ca-SP, the compound did not exert any antithrombin activity. Furthermore, Na-SP, which was prepared by replacement of the calcium in Ca-SP with sodium, accelerated the antithrombin activity of HC II as Ca-SP did. We therefore suggest that the molecular conformation maintained by Ca or Na is indispensable to the antithrombin activity of Ca-SP. The HC II-dependent antithrombin activity of Ca-SP was almost totally abolished by treatment with chondroitinase AC I, heparinase or heparitinase, but not by treatment with chondroitinase ABC and chondroitinase AC II, suggesting that a heparin- or dermatan sulfate-like structure is not responsible for the activation of HC II by Ca-SP. Ca-SP is therefore thought to be a unique sulfated polysaccharide which shows a strong antithrombin effect in an exclusively HC II-dependent manner.

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